United States Department of the Interior

FISH AND WILDLIFE SERVICE

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Memorandum

To: File JAN 16 2019

From: Bill Poytress, Program Manager, Red Bluff Fish and Wildlife Office, USFWS

Subject: Linear-model and genetic-based revisions to brood year 2018 juvenile winter and spring Chinook salmon passage and production estimates

Linear-model revision.–With sufficient numbers of winter-run fry captured by rotary traps, three mark-recapture trials were performed during the peak winter Chinook salmon juvenile outmigration period in October of 2018. Trials were performed to validate expected (i.e., linear-regression modeled) daily trap efficiencies in relation to observed trap efficiencies and ultimately to add trials to the linear model as part of efforts to continually improve the Red Bluff juvenile monitoring program's passage and production estimates. It is not uncommon for the program to verify the accuracy of modeled trap efficiency estimates and/or make changes to trapping operations to better align with predicted or estimated trap efficiencies as fish numbers allow. In October of 2018, two trials were conducted with 4 traps at 100% sampling capacity using naturally produced winter Chinook caught in the Red Bluff traps. Fish were marked and released as part of standard trial practices and nearly identical and distinct differences in observed versus expected (i.e., modeled) efficiencies were noted for these two trials (Figure 1; highlighted in red circle). The third trial reduced the amount of water volume sampled by 50% for one thalweg trap and resulted in values within the prediction intervals (grey lines) of the model and was deemed consistent with modeled efficiencies.

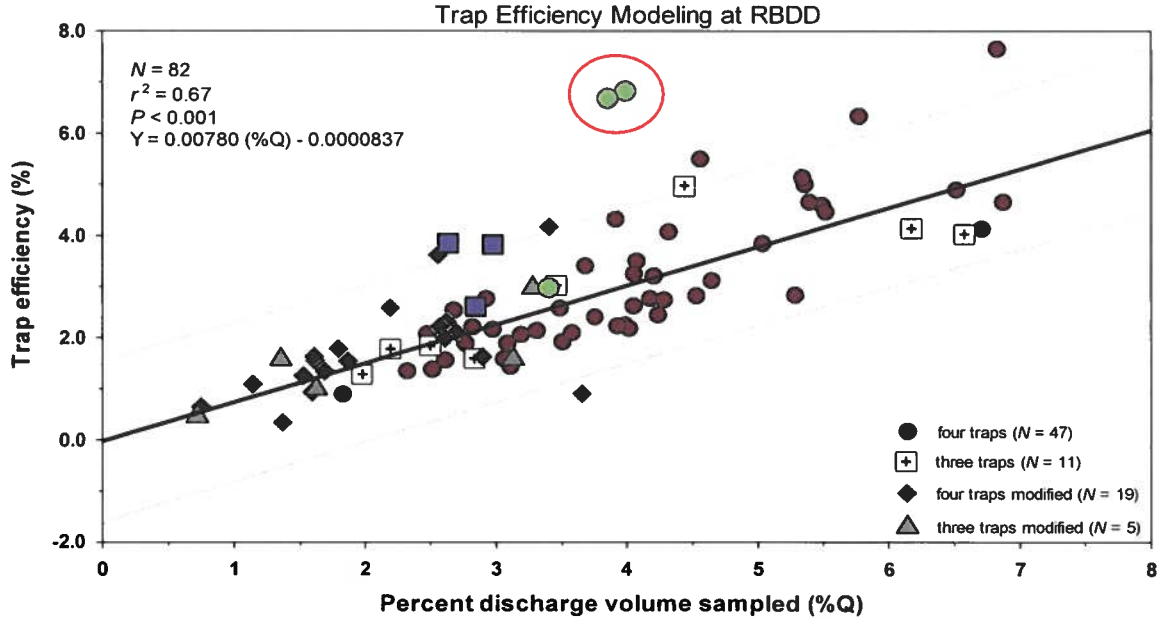

Figure 1. Trap efficiency model indicating fall of 2018 measured efficiency values plotted with (green circles) and without (blue squares) trap in gate 6's recaptures.

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The reason(s) why the first two of three trials resulted in much greater efficiencies than would be predicted by the current model have not been fully determined. It is suspected that the arrangement of the traps across the transect, which varies within and between years, may have simply been sampling far more efficiently at the flows sampled (~ 7,200 cfs) than previous trials have observed. Moreover, changes in channel morphology in the absence of US Bureau of Reclamation operation of the Red Bluff Diversion Dam (RBDD) may have occurred in recent years. It is possible that high flow events, as were seen in 2017, resulted in channel changes upstream and at the RBDD sample site. Changes in stream channel configurations may have altered the migration routes juvenile salmon use during the fall period when the winter Chinook trap efficiency trials were conducted or simply increased the efficiency of the thalweg trap(s). Alternately, behavioral differences in migration patterns during peak fish abundance that could result in efficiencies greater than previously observed may have occurred that were previously undocumented.

Regardless of the actual reason(s) why the two trials were markedly different, the majority of the difference could be singled out to one of the four traps in operation. The trap in gate 6 (mid-channel or thalweg) appears to have been highly efficient at recapturing marked fish and, of the 4 traps was also sampling the greatest volume of water passing the transect (in absolute value and proportion). This situation likely resulted in the high efficiency values in relation to the percent of discharge sampled for the array of traps on the whole. Due to the consistency of the trial results under similar conditions and within a short time frame (i.e., days) during the peak period of winter run passage, the removal of gate 6's data for the months of September and October is expected to result in a more accurate depiction of modeled trap efficiency and subsequent calculations of daily passage.

The removal of data from gate 6 from these calculations results in slightly lower daily passage estimates yet estimates that do not differ statistically (Mann-Whitney Rank Sum Test, U=1652, *P= 0.287*) with or without the inclusion of gate 6's data. The overall reduction in total passage for winter Chinook using 3-trap data versus 4 trap data is 9.2% for the 2018 brood year through November 18, 2018. The linear model used at the Red Bluff trapping location is flexible enough to allow for its use with 3 or 4 traps in operation and use with 3 or 4 traps, modified to sample 50 or 100% of their volume as has been done throughout the 20+ years of sampling at this location.

As a result, daily passage and production estimates tabulated in preliminary bi-weekly reports denoted as "revised" estimates will be posted in parallel with original reports and will include this adjustment for all salmonid passage estimates for the period September and October with results extending through December 31, 2018. Further adjustments to winter and spring Chinook due to genetics will be discussed below and be included as part of the revised estimates. Annual reporting of these findings and a final estimate for winter Chinook will discuss this information in greater detail after the conclusion of the outmigration year.

Genetic-based revision.–During the fall of 2018 and similar to 2017, we had fin clips genetically analyzed from juvenile winter and spring Chinook, designated by length-at-date (LAD) criteria, to verify run designation as part of two genetic sampling projects. These projects are known as the "Improving Vital Rates Estimation Using Parentage-Based Mark Recapture Methods" and the "Central Valley Salmonid Coordinated Genetic Monitoring Project". Both projects have been conducted for three consecutive years (2016, 2017, 2018) and genetic analyses has been conducted in prior years (BY 2015 and BY 2016) on a small sample of fish sacrificed for histological analyses (n = 80/yr) by Dr. Scott Foote of the California Nevada Fish Health Center during the latter half of the drought.

Using the data gathered from standardized genetic sampling (fin clips) of up to 10 winter and 10 spring Chinook salmon collected daily, we were able to evaluate the accuracy of our field-based LAD run assignments used, in part, to generate the brood year 2018 winter and spring Chinook passage and production estimates. The LAD run assignment method has been the standard model used by the Red Bluff Fish and Wildlife Office for run assignment at the RBDD rotary-trap sampling site since 1995. Genetic samples were taken from 2 out of 4 traps per day in a standardized rotation. For instance, when fish numbers were adequate in all traps, we would sample 10 of each run from 2 traps on day 1 and then do the same for the other 2 traps on day 2. During periods of low winter and/spring Chinook abundance, fin clips were collected from 3 or up to 4 traps per day to meet the targeted number of fin clips per day.

Genetic samples (n = 259) were collected from LAD designated spring Chinook between October 16 and November 27, 2018. Prior to November 19, 2018, all samples (n=233) were genetically identified as winter Chinook. As a result, genetically identified winter Chinook were incorrectly assigned to spring Chinook using LAD criteria for a period of 34 days. Incorrectly assigned spring Chinook using LAD during this time period (October 16 to November 18) contributed positive bias to spring run passage estimates and negative bias to winter run passage estimates. The genetic data indicated the need to revise our passage/production estimates for the two runs to more accurately portray juvenile passage and production in 2018 in a similar fashion as 2017, but to a lesser degree in magnitude.

Independently collected adult Chinook salmon data and information from the California Department of Fish and Wildlife (CDFW) provided additional support for the need to revise the winter and spring Chinook juvenile passage/production estimates. In the summer and fall of 2018, the adult winter Chinook carcass survey data indicated later spawning of adults as was seen in 2017 (Figure 2). Sacramento River water temperature analyses conducted by CDFW coupled with winter Chinook redd data estimated the last emergence timing of winter Chinook fry could occur as late as November 18, 2018. Other survey work of adult carcass and redd survey data collected by CDFW and USFWS indicated that spring-run Chinook adults upstream of our sample site in the mainstem Sacramento River and tributaries numbered less than 100 individuals. The first juvenile spring Chinook catch on Clear Creek and Battle Creek screw traps occurred on November 18 and 28, respectively. These data, when combined, provided evidence that the numbers of spring Chinook juveniles we estimated passage of between October 16 and November 18, 2018 was highly unlikely and represent mis-assignment through the use of the LAD criteria model.

Similar to 2017 and based on the contributing factors and data obtained in the fall of 2018, I felt it necessary to reassign fish that, according to LAD criteria, fell into the spring run category to the winter run category based on the results of genetic analyses. I used the genetic data to determine that the period of October 16 through November 18, 2018 was appropriate to reassign all spring run fish to winter run. Biweekly reports' passage data for both runs have been revised for the period of October 8, 2018 through November 18, 2018 to incorporate the revised daily estimates. This revision will be incorporated into passage estimates through the remainder of the brood year 2018 winter and spring Chinook outmigration period. These data will be used as the official passage and production estimates and be detailed in an annual report that will be completed in the coming year. Both sets of reports have been placed on the Red Bluff Fish and Wildlife Office's website biweekly report page for 2018 for interested parties to compare pre- and post-genetic correction passage estimates for each run.

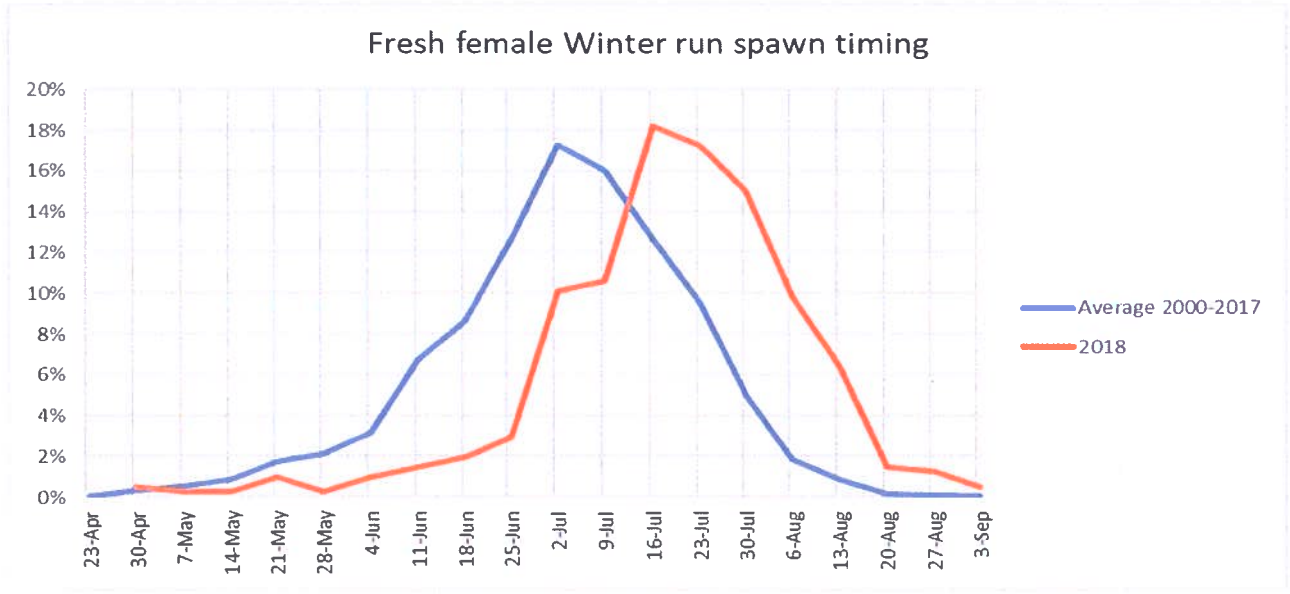

Figure 2. Winter Chinook spawning temporal distribution comparison on 2018 data to average of 2000-2017 data. Data based on carcass recoveries and provided by CDFW.